SEASONAL FOODS OF COYOTES IN SOUTHEASTERN IDAHO: A MULTIVARIATE ANALYSIS

James G. MacCracken[1,2] and Richard M. Hansen[1]

ABSTRACT.— Seasonal foods of coyotes (*Canis latrans*) inhabiting the Idaho National Engineering Laboratory site were examined using step-wise discriminant analysis. Significant differences ($P < 0.01$) were detected among seasons in food consumption by coyotes, where univariate statistical analysis failed to recognize differences. Recognition of seasonal changes in foods consumed by coyotes is essential to understanding coyote feeding strategies. The role opportunistic behavior plays in coyote food selection on the study area is questioned.

Coyotes (*Canis latrans*) have been and continue to be a center of controversy (Bailey 1907, Taylor et al. 1979). As a result, numerous studies have been published dealing with many aspects of coyote ecology (Bekoff 1978). Food habits of coyotes are well documented in the literature for a variety of ecological conditions (Murie 1935, Clark 1972, MacCracken 1981). Few studies, however, have evaluated coyote foods on a seasonal basis (Meinzner et al. 1975). Although many studies have shown that one or two items make up the bulk of coyote foods (Sperry 1941, Murie 1945, Gier 1968, Johnson and Hansen 1979a, and others), the relative abundance of these prey species experiences seasonal fluctuations. The seasonal availability and abundance of some food items would presumably result in seasonal differences in coyote diets if coyotes are truly opportunistic feeders. Johnson and Hansen (1979a) and MacCracken (1981) both questioned the degree opportunistic behavior plays in coyote feeding.

In the past, discussion of seasonal differences in coyote foods has largely been based on observed changes of relative amounts of a single item in a coyote dietary. Statistical analysis has been limited due to the number of variables (food items) involved, violation of assumptions of univariate tests, and the lack of a test's power in detecting differences.

The purpose of this paper is to present data on seasonal coyote foods in southeastern Idaho and to discuss the application of a multivariate procedure in detecting differences in coyote food selection.

Study Area and Methods

This study was conducted on the Idaho National Engineering Laboratory (INEL) site in southeastern Idaho from October 1977 through July 1979. Johnson and Hansen (1979a) studied coyote food habits on the INEL site from July 1975 to July 1977. The INEL site was located on the Upper Snake River Plain, which is dominated by sagebrush-grass vegetation associations (Harniss and West 1973, Anderson and Holte 1981). Eggler (1941) gave a description of the geology and climate of the plain.

The INEL site was divided into two areas based on the presence or absence of coyote control programs. Control activities were confined to the peripheral portion of the INEL site. Livestock grazing was also confined to the peripheral portion of the study area.

Coyote feces were collected from 25 permanent transects systematically located as described by Johnson and Hansen (1979a). We included transitional areas defined by Johnson and Hansen as being part of the central area in this study. Transects were

[1]Department of Range Science, Colorado State University, Fort Collins, Colorado 80523.
[2]Present address: USDA, Forest Service, Rocky Mountain Forest and Range Experiment Station, Rapid City, South Dakota 57701.

gleaned of all coyote feces in July 1977. Coyote feces examined in this study were collected in October 1977 and 1978, representing summer diets, in December 1977, representing fall food consumption, June 1978 and April 1979, representing primarily winter diets, and July 1979, which represented a period of spring feeding by coyotes.

Coyote feces were dried at 60 C for 48 hours in a forced-air-drying oven, then weighed. Each dried scat was placed in a fine mesh nylon bag, soaked for 24 hours in tap water, then cleared of all soluble material by agitating in a clothes washer. After all soluble material had been removed, scats were tumbled dry in a clothes drier.

Food items in scats were identified by comparison with reference materials and recorded by frequency of occurrence. Frequency of occurrence of food items was converted to grams of dry matter ingested following procedures explained by Johnson and Hansen (1979b).

An estimate of coyote food consumption was determined for each of the 25 transects for each collection date. Five diet estimates were randomly selected for analysis, using a table of random digits (Snedecor and Cochran 1967) for each collection date and both areas of the INEL site, which included approximately 550 feces.

Differences in coyote food consumption among seasons were tested for significance with step-wise discriminant analysis (Hope 1968, Cooley and Lohnes 1971, Klecka 1975). Discriminant analysis determined which variables (food items) were the most useful in distinguishing between seasons, developed equations (discriminant functions) that classified diet estimates as to season of feeding, and indicated which variables contributed the most information to a particular function.

RESULTS

Nuttall cottontails (*Sylvilagus nuttali*), montane voles (*Microtus montanus*), and northern pocket gophers (*Thomomys talpoides*) made up the bulk of coyote foods during the period of this study (Table 1). Significant differences ($P < 0.01$) were detected among seasons in coyote food consumption as each variable was entered into discriminant analysis. All seasonal diets were different ($P < 0.01$) after 15 of 21 food items had been considered. Those 15 food items were the

TABLE 1. Mean (± SE) percent relative dry weight (g) of food items recovered from coyote feces collected on a seasonal basis from the Idaho National Engineering Laboratory. Number of diet estimates is in parentheses.[1]

Food items	Season			
	Winter(12)	Spring(14)	Summer(22)	Fall(12)
Mammals				
Sylvilagus nuttalli	32 ± 8	40 ± 8	69 ± 5	61 ± 6
Brachylagus idahoensis	4 ± 4	13 ± 5	2 ± 1	2 ± 2
Lepus californicus	9 ± 5	°	1 ± 1	4 ± 2
L. townsendi	1 ± 1	2 ± 1		
Microtus montanus	12 ± 5	16 ± 6	11 ± 3	7 ± 3
Thomomys talpoides	3 ± 2	11 ± 4	4 ± 2	4 ± 2
Perognathus sp.	1 ± 1	1 ± 1	5 ± 2	1 ± 1
Cricetid mice	3 ± 2	1 ± 1	1 ± 1	7 ± 4
Antilocapra americana	3 ± 2	1 ± 1	1 ± 1	7 ± 3
Livestock	11 ± 6		1 ± 1	
Spermophilus townsendi	1 ± 1	9 ± 3	°	2 ± 1
Dipodomys ordi	6 ± 4	1 ± 1	°	1 ± 1
Eutamias minimus		2 ± 1		2 ± 2
Marmota flaviventris	3 ± 3			
Neotoma cinerea	1 ± 1			
Birds	1 ± 0	2 ± 1	1 ± 1	°
Reptiles	°		2 ± 1	°
Insects	4 ± 4	1 ± 0	1 ± 0	°
Seeds	°	°	°	°
Plant fragments	1 ± 0	°	°	1 ± 0
Grass macrofragments	5 ± 5	°	°	

°<1%

[1]Diet estimates were derived from many feces. A total of 550 feces were analyzed.

most useful in differentiating among seasonal diets of coyotes and accounted for 95 percent of data variation. Those food items, in order of significance, were: Townsend ground squirrels (*Spermophilus townsendi*), Nuttall cottontails, pygmy rabbits (*Brachylagus idahoensis*), plant fragments, pronghorn (*Antilocapra americana*), pocket mice (*Perognathus* sp.), bushy-tailed woodrats (*Neotoma cinereus*), reptiles, whitetail jackrabbits (*Lepus townsendi*), montane voles, Cricetid mice, northern pocket gophers, birds, least chipmunks (*Eutamias minimus*), and macrofragments of grass. Plant fragments were from prey stomachs, and grass macrofragments were leaves directly consumed by coyotes.

Certain food items were associated with a season of feeding by coyotes as revealed by examination of discriminant classification function coefficients (Table 2). Birds, Townsend ground squirrels, plant fragments, and bushy-tailed woodrats contributed information during all seasons; however, the additional occurrence of reptiles in coyote scats was indicative of summer diets, pronghorn of fall diets, macrofragments of grass winter diets, and whitetail jackrabbits of spring diets. All food items were positively associated with seasonal diet selection, except bushy-tailed woodrats.

Other food items also exhibited differences ($P < 0.01$) in seasonal consumption by coyotes, but contributed relatively little information to explained variation. Insects, Ord's kangaroo rats (*Dipodomys ordi*), livestock, and yellow-bellied marmots (*Marmota flaviventris*) occurred most frequently in winter scats.

Discussion

Coyote food selection during the period of this study was similar to that reported by Johnson and Hansen (1979a). Johnson and Hansen (1979a), however, did not report any significant differences in coyote foods among seasons when comparing means with a student's *t*-test. MacCracken (1980) lumped coyote foods into five categories (leporids, rodents, ungulates, birds, and insects) and tested for differences among collection dates with factorial analysis of variance. This procedure also failed to detect significant differences in seasonal occurrence of coyote foods. Discriminant analysis has value in the treatment of food habits data in that all food items can be evaluated and significant changes in food consumption are detectable.

Lehner (1976) stated that knowledge of coyote feeding strategies could be useful in altering the role livestock and game animals play in those strategies. To fully understand coyote feeding strategies, wildlife managers and researchers must consider seasonal changes in food consumption by coyotes and be able to determine which food items

Table 2. Discriminant classification function coefficients of 15 important food items of seasonal diets of coyotes from southeastern Idaho.

	Season			
	Winter	Spring	Summer	Fall
Mammals				
Sylvilagus nuttalli	0.46	0.75	0.69	0.70
Brachylagus idahoensis	0.69	1.18	0.86	0.98
Lepus townsendi	0.55	1.55	0.81	0.86
Microtus montanus	0.56	0.86	0.77	0.79
Thomomys talpoides	0.37	0.63	0.52	0.52
Perognathus sp.	0.20	0.43	0.66	0.39
Cricetid mice	0.48	0.76	0.62	0.88
Antilocapra americana	0.73	1.12	0.79	1.27
Spermophilus townsendi	0.96	1.82	1.11	1.41
Eutamias minimus	0.75	1.25	0.92	1.22
Neotoma cinereus	−0.23	−2.68	−2.21	−2.75
Birds	0.97	1.75	0.99	1.27
Reptiles	0.16	0.41	1.30	0.51
Plant fragments	8.61	9.96	3.90	9.38
Grass macrofragments	0.82	1.09	0.86	0.99
Constant	−21.99	−30.84	−36.17	−42.34

change significantly in relation to other foods consumed and in relation to their availability.

Food items that were indicative of a particular season of feeding by coyotes would generally be expected to exhibit seasonal fluctuations in consumption by coyotes. The relationship of some foods to seasonal use by coyotes, however, was not easily recognized. Grass in winter diets and whitetail jackrabbits in spring diets may represent mathematical relationships important in discriminant function analysis. Nuttall cottontail, pygmy rabbit, montane vole, and most other small mammals occurred in coyote feces in relation to expected seasonal population changes of these prey items. Insects (Coleoptera, Hymenoptera) were consumed in significantly higher proportions by coyotes on the INEL site during winter, when insect populations are low and dormant. Insects insure overwinter survival by burrowing into soil, ground litter, and other substrates. Turkowski (1980) reported a relatively high occurrence of insects in winter scats of coyotes and concluded that coyotes dig beneath the snow and into soil to obtain food.

The seasonal abundance of certain foods in coyote feces supports the idea that coyotes are opportunistic feeders (Meinzer et al. 1975). Nevertheless, the fact that leporids accounted for ½ to ⅔ of coyote diets on the INEL site suggests selectivity. Jackrabbit (*Lepus* spp.) densities were relatively low during this study, and Nuttall cottontails were the most abundant leporid (MacCracken and Hansen 1982). When montane voles and northern pocket gophers are also considered, these food items account for 61 to 87 percent of coyote diets. Johnson and Hansen (1979a) and MacCracken (1980) both reported the occurrence of over 40 items in coyote feces from the INEL site. The fact that 15 percent of all available foods contribute to over 80 percent of food ingested by coyotes supports the contention that coyotes prefer a relatively few mammalian species as food on the INEL site.

Acknowledgments

The authors thank O. D. Markham, W. J. Arthur, M. K. Johnson, G. C. Lucich, R. L. Potter, E. R. Johnson, and D. Simonson for their participation in this study. This project was supported in part through Grant DE-AS07-76ID01526, MOD 008 from the U.S. Department of Energy, Idaho National Engineering Laboratory Site Ecology Program to Colorado State University.

Literature Cited

ANDERSON, J. E., AND K. E. HOLTE. 1981. Vegetation development over 25 years without grazing on sagebrush-dominated rangeland in southeastern Idaho. J. Range Manage. 34:25–29.

BAILEY, F. 1907. Destruction of wolves and coyotes. USDA Bur. of Biol. Survey Circ. 63.

BEKOFF, M. 1978. Coyotes: biology, behavior, and management. Academic Press, New York. 383 pp.

CLARK, F. W. 1972. Influence of jackrabbit density on coyote population change. J. Wildlife Manage. 36:343–356.

COOLEY, W. W., AND P. R. LOHNES. 1971. Multivariate data analysis. John Wiley and Sons, New York. 364 pp.

EGGLER, W. A. 1941. Primary succession on volcanic deposits in southern Idaho. Ecol. Monog. 11:277–298.

GIER, H. T. 1968. Coyotes in Kansas. Kansas Agric. Expt. Sta. Bull. 393. 118 pp.

HARNISS, R. O., AND N. E. WEST. 1973. Vegetation patterns of the National Reactor Testing Station, southeastern Idaho. Northwest Sci. 47:30–43.

HOPE, K. 1968. Methods of multivariate analysis. Univ. of London Press. 165 pp.

JOHNSON, M. K., AND R. M. HANSEN. 1979a. Coyote food habits on the Idaho National Engineering Laboratory. J. Wildlife Manage. 43:951–955.

———. 1979b. Estimating coyote food intake from undigested residues in scats. Amer. Midland Nat. 102:363–367.

KLECKA, W. R. 1975. Discriminant analysis. Pages 434–462 *in* W. H. Nie, C. H. Hull, J. G. Jenkins, K. Steinbrenner, and D. H. Bent, eds., Statistical package for the social sciences. 2d ed. McGraw-Hill, New York. 675 pp.

LEHNER, P. N. 1976. Coyote behavior: implications for management. Wildl. Soc. Bull. 4:120–126.

MACCRACKEN, J. G. 1980. Feeding ecology of coyotes on the Upper Snake River Plain, Idaho. Unpublished thesis. Colorado State Univ. Fort Collins, Colorado. 85 pp.

———. 1981. Coyote foods in southwestern Colorado. Southwest. Nat. 26:317–318.

MACCRACKEN, J. G., AND R. M. HANSEN. 1982. Herbaceous vegetation of habitat used by blacktail jackrabbits and nuttall cottontails in southeastern Idaho. Amer. Midland Nat. 107:180–184.

MEINZER, W. P., D. N. UECKERT, AND J. T. FLINDERS. 1975. Food niche of coyotes in the rolling plains of Texas. J. Range Manage. 28:22–27.

MURIE, O. J. 1935. Food habits of the coyote in Jackson Hole, Wyoming. USDA Circ. 362. 24 pp.

———. 1945. Notes on coyote food habits in Montana and British Columbia. J. Mammal. 26:33–40.

Sperry, C. C. 1941. Food habits of the coyote. USDI Fish and Wildl. Serv. Res. Bull. 4. 69 pp.

Snedecor, G. W., and W. G. Cochran. 1967. Statistical methods. Iowa State Univ. Press, Ames, Iowa. 593 pp.

Taylor, R. G., J. P. Workman, and J. E. Bowns. 1979. The economics of sheep predation in southwestern Utah. J. Range Manage. 32:317–321.

Turkowski, F. J. 1980. Carnivora food habits and habitat use in Ponderosa Pine forests. USDA Forest Service Res. Paper RM-215. 9 pp.